ENVIRONMENTAL RESOURCES MANAGEMENT

FINAL REPORT

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The Boeing Company

Well 70 Interim Action Hydraulic Capture Report

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1.0 INTRODUCTION

On behalf of the Old Hammer Field Steering Committee (OHFSC), Environmental Resources Management (ERM) has prepared this *Well 70 Interim Action* (IA) *Hydraulic Capture Report.* This report summarizes the work completed in accordance with the *Well 70 Interim Action Ground Water Monitoring Program Sampling and Analysis Plan* (SAP) (ERM, 1998) prepared for the Well 70 project in Fresno, California. On 25 January 1999, the City of Fresno reactivated Municipal Well 70 as a source of public drinking water supply. This well is located along the southern boundary of the Fresno Yosemite International Airport (former Fresno Air Terminal), an active municipal airport near the intersection of McKinley and Peach Avenues (Figure 1-1).

Well 70 was taken out of service in 1989 due to the presence of trichloroethene (TCE) in ground water samples above the state and federal Maximum Contaminant Level (MCL) of 5 micrograms per liter (µg/L). The TCE detected in ground water samples from Well 70 is believed to have originated in what is referred to as Area 1 of the Old Hammer Field (OHF) Site, which is a related project encompassing a portion of the Fresno Yosemite International Airport as described further below. Tetrachloroethene (PCE) believed to have originated at the California Air National Guard (CANG) facility, which encompasses the southwestern portion of the airport, has also been detected in Well 70.

The Well 70 IA was based upon two primary components:

- To design and construct a wellhead treatment system capable of removing TCE and other volatile organic compounds (VOCs) at a pumping rate of 2,000 gallons per minute (gpm). This water was then conveyed to the City water supply system.
- To conduct ground water monitoring to determine the impact and effectiveness of Well 70 pumping on aquifer conditions and the capture capacity of Well 70 on the VOC plume—the subject of the SAP.

1.1 *DOCUMENT ORGANIZATION*

This document includes five sections and one appendix:

- Section 1 presents the relationship of the Well 70 IA to the OHF Area 1 project, the Well 70 IA objectives, and the ground water monitoring program objectives;
- Section 2 summarizes relevant information concerning the site, including our current understanding of the hydrogeologic conditions and extent of VOCs in ground water;
- Section 3 presents the activities completed during the ground water monitoring program;
- Section 4 presents the results of these monitoring activities;
- Section 5 presents the conclusions of the Well 70 IA ; and
- Section 6 cites appropriate references.

Data summary tables and figures follow the text. Post-startup hydrographs are included in Appendix A.

1.2 *BACKGROUND—OHF AREA 1 AND WELL 70 IA PROJECT STRUCTURE*

The OHF Site (Figure 1-1) encompasses 1,598 acres where industrial operations occurred and site investigations have been performed by OHFSC. The OHFSC is comprised of military and civilian entities that have been associated with the site and conducted activities since 1941. The site derives its name from the former Hammer Army Air Field (also known as Hammer Field), which was an active military facility from 1941 through 1946. The history of this area, which occupies a portion of the Fresno Yosemite International Airport (1918 acres) but does occur entirely within its boundaries, is described in the *Preliminary Assessment Report* (ERM, 1991) and the *Draft Overall Site-Wide Remedial Investigation/Feasibility Study* (RI/FS) *Shell Workplan* (ERM, 1994).

Available evidence indicates that TCE detected in ground water samples from Well 70 is believed to have originated in a portion of the OHF Site that is referred to as Area 1 (specifically the Hangar P3 area of Area 1), corresponding to the southeastern portion of the Fresno Yosemite International Airport (Figure 1-2). The investigation and remediation of TCE and other VOCs in OHF Area 1 is being administered by the OHFSC, which comprises:

- City of Fresno,
- United States Army Corps of Engineers (USACE),
- National Guard Bureau (NGB), and
- Boeing Corporation.

1.3 *WELL 70 INTERIM ACTION OBJECTIVES*

For the Well 70 IA , different ground water extraction, treatment, and use/disposal options were evaluated for effectiveness, implementability, and cost. There were four main goals:

- To supply drinking water at a rate of 2,000 gpm. This water is treated with a combined air stripper and granular activated carbon system prior to discharge to the drinking water system.
- To ensure that the IA reduces the migration of chemicals in ground water downgradient of Well 70 that might impact downgradient potable water supply systems.
- To create a methodology for consistency with a final remediation approach for the area.
- To represent a cost-effective approach for treating water for potable consumption.

1.4 *WELL 70 INTERIM ACTION MONITORING (IA) PROGRAM OBJECTIVES*

The objectives of the Well 70 IA ground water monitoring program were to:

- Determine the influence of pumping Well 70 on hydraulic gradients and ground water flow patterns, both lateral and vertical;
- Evaluate the impact of pumping Well 70 on the distribution of TCE and PCE in ground water; and
- Generate hydrogeologic data for input to ground water modeling in support of the OHF Area 1 FS.

2.0 SITE CONDITIONS

This section describes the project area, investigation history, hydrogeologic conditions, and extent of TCE and PCE in ground water in the vicinity of Well 70.

2.1 SITE DESCRIPTION

Well 70 is adjacent to the southern boundary of the OHF Site and the Fresno Yosemite International Airport at the southeast corner of the intersection of Peach and McKinley Avenues (Figure 1-1). Ground surface elevations on OHF vary from 315 to 345 feet above mean sea level (msl), and the elevation at Well 70 is approximately 320 feet above msl. Well 70 has a total depth of 400 feet below ground surface (bgs). The regional land surface slopes to the southwest at a grade of approximately 15 feet per mile. Temperatures in the area are generally mild (mean annual temperature of 62° Fahrenheit), with an average annual rainfall over the last 50 years of 10.3 inches (ERM, 1997). Land use to the north, south, and west of the airport is predominantly residential and industrial. East of this area, land use is primarily agricultural.

2.2 PREVIOUS INVESTIGATIONS

Several subsurface investigations have been conducted in the Well 70 area. The summaries of hydrogeologic conditions and VOCs in ground water that follow are based on the results of these investigations. Primary sources of information from Area 1 of OHF include:

- *Area 1 Site Inspection Report* (ERM, 1992);
- *Final Area 1 Site Inspection Report* (ERM, 1995);
- *Final Area 1 Phase I Remedial Investigation Data Summary Report* (ERM, 1996); and
- *Final Area 1 Remedial Investigation Report* (Area 1 RI Report; ERM, 2000).

These documents present hydrogeologic data from an area that extends from Well 70 approximately 1 mile to the northeast and approximately 1 mile to the southwest (Figure 1-2).

Data from the southern portion of Area 1, corresponding to the CANG base immediately northeast of Well 70, are presented in the *Final Remedial Investigation Report for the 144th Fighter Interceptor Wing, California Air National Guard,* (IT Corporation, 1997).

2.3 *HYDROGEOLOGIC CONDITIONS*

The project area lies along the eastern margin of California's Central Valley, which is bounded by the Sierra Nevada and Coast Ranges to the east and west, respectively (Norris and Webb, 1990). The near-surface geology of interest in the vicinity of OHF is characterized by unconsolidated, alluvial fan deposits derived from the Sierra Nevada (Page et al., 1969). The stratigraphy beneath the site generally consists of silts, sandy silts, silty sands, sands, and gravelly sands. Detailed descriptions of the stratigraphy beneath the site and geologic cross-sections are provided in the Area 1 RI Report.

Just prior to the start of pumping in January 1999, ground water in the vicinity of Well 70 was encountered at a depth of approximately 90 feet bgs. The water table has declined approximately 50 feet since 1952, due to intensive regional pumping.

The uppermost water-bearing zone (defined in the Area 1 RI Report as the combined A/B aquifer zone) is generally unconfined, although semiconfined conditions may exist locally due to the presence of fine-grained aquitards. Deeper, confined aquifer zones (C through H Zones) have been identified to depths of approximately 350 feet near Well 70. Based on the presence of TCE in ground water below 300 feet bgs, it is likely that much of the stratigraphic sequence to this depth is hydraulically connected due to the leaky or discontinuous nature of the aquitards.

Data collected during the RI indicate that ground water generally flows southwest across the OHF Site under a horizontal gradient of approximately 0.0025 to 0.0040 foot per foot (ft/ft). Ground water flow patterns and gradients are influenced locally by infiltration basins and water supply wells. In addition to Well 70, the aquifer is pumped intensively for water supplies, including 22 active wells near the plume. Vertical gradients range from nonexistent to a strong downward gradient near water supply wells. Based on aquifer tests, hydraulic conductivity values for the aquifer zones range from 4.3 to 243 feet per day (ft/day). Ground water flow velocity estimates for these zones range from 0.022 to

2.40 ft/day, or 8 to 820 feet per year. Vertical hydraulic conductivity values of aquitards are as low as 7.4 x10^{-5} ft/day.

2.4 *TCE AND PCE IN GROUND WATER*

TCE is the primary VOC detected in ground water in the OHF area, including near Well 70. Detections of TCE above the state and federal MCL of 5 µg/L resulted in the deactivation of Well 70 in 1989. The greatest concentrations of TCE (up to 5,100 µg/L) occur at the water table in the vicinity of Hangar P3 in OHF Area 1 (Figure 2-1). The TCE plume extends southwest from the Hangar P3 area toward the residential area southwest of Well 70, which is consistent with existing ground water flow data.

The extent of the plume in different aquifer zones varies significantly due to differences in the hydraulic properties and depths of these zones. A cross section of the stratigraphy to a depth of 420 feet bgs along the projected axis of the OHF Area 1 TCE plume, with Well 70 along the southwest margin, is illustrated on Figure 2-2. Another cross section of the Well 70 area, oriented perpendicular to the axis of the plume, is illustrated on Figure 2-3. As shown on these figures, the stratigraphy beneath the water table has been divided into fine- and coarse-grained layers and correlated between borings, where possible. Many of these intervals can be correlated partially or entirely across the area, although lateral stratigraphic variability is common:

- TCE in the A/B Zone, from the water table to approximately 120 feet bgs, occurs over an area corresponding to the upgradient two-thirds of the overall plume.
- The largest areal extent of the plume occurs in the C and D Zones, from approximately 130 to 190 feet bgs.
- TCE in deeper intervals, from 200 to 340 feet bgs, is confined to the central portion of the plume near Well 70 (Figure 2-2). The historical operation of this well is thought to have caused TCE to migrate down to deeper intervals relative to other areas of the plume.

PCE has also been detected in Well 70 (ERM, 1997) and at the CANG facility immediately to the northeast (IT Corporation, 1997). PCE is detected at lower concentrations (less than 110 µg/L) and does not extend as deep (typically less than approximately 120 feet bgs) as TCE in the area. The lateral and vertical distribution of PCE near Well 70 is illustrated on Figures 2-4 and 2-5.

3.0 GROUND WATER MONITORING PROGRAM ACTIVITIES

This section describes the activities completed as part of the Well 70 IA ground water monitoring program. Activities completed during the Well 70 IA include:

- Installation of additional monitoring wells;
- Water level monitoring; and
- Ground water sampling and analysis.

3.1 MONITORING WELL INSTALLATION

Eight monitoring wells were installed in January and February 1998 as part of the Well 70 IA ground water monitoring program (Figure 3-1), including:

- HFMW-09C;
- HFMW-24A;
- HFMW-25A and HFMW-25C;
- HFMW-26C;
- HFMW-27A and HFMW-27C; and
- HFMW-28C.

These wells were installed to expand the monitoring network in the water table zone, referred to as the A/B Zone (approximately 70 to 120 feet bgs), as well as the C Zone (approximately 140 to 160 feet bgs). Monitoring well locations and screen zones were modified slightly from those described in the Well 70 SAP. The modifications were based upon specific input from exploratory borehole data and revisions to the conceptual model of the TCE plume.

Monitoring well boreholes were drilled using mud rotary drilling techniques. A summary of well depths and screen intervals are presented in Table 3-1. Boring logs for each of the new monitoring wells are provided in the Area 1 RI Report.

Geophysical logs were completed on each Well 70 monitoring well before well construction. Included on these logs are resistivity, short- and long-normal resistivity, spontaneous potential, and natural gamma.

Monitoring well completion reports and well development forms were also completed for each well. Copies of all of these forms are included in the Area 1 RI Report.

3.2 *WATER LEVEL MONITORING*

Water level data were collected from 45 wells between June 1998 (approximately 6 months prior to the startup of Well 70) and August 1999 with electronic data loggers and/or manually (Table 3-2). The purpose of this prestart and startup monitoring was to collect drawdown data within the pumping area of influence. This monitoring was divided into three phases, including:

- Long-term pre-startup monitoring (12-hour readings for an approximate 6 month period prior to system startup);
- Short-term pre-startup monitoring (10-minute readings for a 1-week period prior to system startup); and
- System startup monitoring (logarithmically-spaced readings from the day of system startup to over 6 months after startup).

The long-term and short-term pre-startup monitoring is used to establish nonpumping baseline potentiometric surface conditions. The system startup monitoring was completed to record the responses of each well to the hydraulic stresses induced by pumping at Well 70 (similar to a traditional long-term aquifer test). Table 3-2 summarizes the monitoring schedule (timing and frequency), methods (manual and/or automated measurements), and well construction information.

3.3 *GROUND WATER QUALITY MONITORING PROGRAM SUMMARY*

Water quality data were collected from 16 wells (Table 3-3) prior to Well 70 startup. Water quality data could only be collected from 11 of these wells after Well 70 startup because five of the A Zone wells became dry.

The purpose of continued water quality monitoring is to evaluate the influence of pumping at Well 70 on the distribution of any/all VOCs in the area, with a focus on TCE and PCE. Water quality monitoring was divided into two periods:

- Pre-startup Sampling – used to establish nonpumping VOC concentrations.

- Post-startup Sampling - used to document changes in the TCE/PCE plumes in response to the pumping of Well 70.

Table 3-3 summarizes the sampling schedule and well construction information. All samples were analyzed for chlorinated VOCs by United States Environmental Protection Agency (USEPA) Method 8021.

4.0 GROUND WATER MONITORING PROGRAM RESULTS

This section presents water level and water quality data that were collected as part of the Well 70 startup monitoring program. These data are presented in Tables 4-1 and 4-2 and in Figures 4-1 through 4-15 of this report.

4.1 WATER LEVEL DATA

Both pre- and post-startup water level data are presented below. It is important to note that the water level monitoring program was focused on two primary aquifer zones: the combined A/B Zone and the C Zone.

- "A" Zone designated wells (e.g., HFMW-24A) are shallow, water table wells, typically screened above 100 feet bgs (Table 4-1).
- "B" designated wells (e.g., MWBP-05B) are screened slightly deeper (but typically no deeper than 120 feet bgs).
- The "A/B Zone" refers to a verified interconnection of the "A" and "B" Zone upon hydrologic and stratigraphic data collected from wells in the "A" and "B" Zones during the Area 1 RI.
- C-Zone designated wells are in deeper, confined zones, typically screened between 140 and 160 feet bgs. Monitoring well and HydroPunch data collected to date indicate that the maximum downgradient extent of the TCE plume occurs in the C Zone.

4.1.1 Pre-Startup Water Level Data

To analyze the impact of pumping at Well 70 on local ground water flow, the background conditions prior to system startup were monitored to create a baseline for comparison to post-startup conditions. This section presents background potentiometric surfaces, background vertical gradients, and background hydrographs for the site.

4.1.1.1 *Background Ground Water Flow*

Manual ground water elevation data were collected for the A/B Zone and the C Zone prior to Well 70 startup. These data were used to create potentiometric surface maps (Figures 4-1 and 4-2, respectively). These maps were generated using 1 and 2 December 1998 water levels, as presented in the *1998 Annual Ground Water Monitoring Report* (ERM, 1999).

Additional data from January pre-startup monitoring events are included in Table 4-1.

The potentiometric surface maps for both the A/B Zone (Figure 4-1) and C Zone (Figure 4-2) indicate a generally southwestern ground water flow direction. This flow direction is consistent with previous data collected from the site and historical Fresno Irrigation District maps of the region. The A/B and C aquifer zones both exhibited an average horizontal hydraulic gradient of approximately 0.002 ft/ft during the December 1998 monitoring event.

4.1.1.2 *Background Vertical Gradients*

As presented in the *1998 Annual Ground Water Monitoring Report* (ERM, 1999b) pre-pumping vertical hydraulic gradients between the A and C aquifer zones and between the C and E aquifer zones were calculated using potentiometric data from monitoring well clusters across the site.

Based on data collected between February 1995 and December 1998, vertical gradients between individual A and C Zone monitoring wells ranged from 0.004 ft/ft to -0.023 ft/ft (in which positive gradients indicate upward flow potential; negative gradients indicate downward flow potential). Vertical gradients between individual C and E Zone monitoring wells between April 1998 (when the first C Zone wells were installed) and December 1998 ranged from 0.001 ft/ft to -0.054 ft/ft. The strongest vertical gradients within the monitored area were observed at the HFMW-22C/HFMW-22E cluster, which is adjacent to a privately owned irrigation well. The strong downwards gradients in this area may be related to pumping in the FAA well and City Well 84.

4.1.1.3 *Pre-Pumping Hydrographs*

Pre-pumping ground water elevations were recorded from three C Zone wells between June 1998 and January 1999 using electronic dataloggers. The three C zone wells are:

- HFMW-25C,
- HFMW-09C, and
- HFMW-28C.

These background data are presented on Figure 4-3, and show that ground water elevations decreased slightly (approximately 1 foot) between June 1998 and January 1999. In general, ground water elevations were stable with a gradual decrease, which is likely due to seasonal influences. Short-term water level perturbations prior to 25 January 1999 represent temporary pump testing and maintenance work performed by the City of Fresno during the treatment system construction. These data indicate that factors other than the startup of Well 70 (such as pumping from other nearby production wells) do not exhibit significant influences on water levels near Well 70 in the C Zone, and therefore do not need to be considered in our analyses.

4.1.2 *Post-Startup Water Level Data*

As stated previously, water level measurements were collected both electronically and manually from numerous wells throughout the site prior to and after Well 70 startup. Manual water level measurements have been summarized in Table 4-1, and electronic data are presented graphically in Appendix A. This section summarizes the water level data collected during the Well 70 IA and presents hydrographs, a distance-drawdown evaluation, and a discussion of vertical gradients.

4.1.2.1 *Hydrograph Evaluation*

Hydrographs have been prepared for all wells from which electronic data were collected (Appendix A). Each hydrograph presents the electronic water level data, manual water level data (if available, after electronic data collection ended), the Well 70 flow rate, and the Well 70 shutdown periods. Information on several A Zone hydrographs terminate before the end of August because the wells went dry.

Figure 4-3 presents combined pre- and post-startup hydrographs for wells HFMW-25C, HFMW-09C, and HFMW-28C. As with the hydrographs in Appendix A, the Well 70 flow rate and shutdown periods are also shown for reference. Figure 4-3 illustrates that Well 70 exerts a strong influence on water levels throughout the study area.

Each hydrograph shows a consistent response and direct correlation between Well 70 pumping and the ground water elevation in each well. Additionally, these hydrographs demonstrate that the influence of Well 70 decreases with increasing distance away from Well 70. These hydrographs also show that with the exception of some temporary Well 70 shutdown periods, ground water elevations in each well continue to decrease at a steady and predictable rate. Tapering of these time-drawdown graphs is likely to occur in the future when recharge to the aquifer zones meets the discharge rate of Well 70.

4.1.2.2 *Distance-Drawdown Evaluation*

A distance-drawdown graph was prepared using manually collected C Zone water level data as follows:

- Startup — 25 January 1999
- Startup + 4 days — 29 January 1999
- Startup + 213 days — 26 August 1999 (Figure 4-4)

This graph shows straight-line relationships between the drawdown in a well and the logarithmic distance of the well from Well 70. This graph illustrates both the lateral influence of pumping from Well 70 at a given point in time (known as the "cone of depression") and the expansion of this cone of depression over time.

Due to the confined nature of the C Zone, rapid expansion of the cone of depression was observed. For example, four days after pumping began, measurable influence occurred almost 3,000 feet away from Well 70 (Figure 4-4). As pumping continued, drawdown continued to increase, as did the lateral influence of pumping. Based on the distance-drawdown relationship at the site, Well 70 appears to depress ground water elevations well beyond the Hangar P3 and Southeast Plume source areas. Well 70 appears to influence not only site ground water, but also ground water in areas that are several thousand feet beyond the site -- areas that are likely also influenced by pumping from other nearby water supply wells.

A distance-drawdown graph using A/B Zone data is also presented on Figure 4-4. The distance-drawdown relationships are not as clear in the A/B Zone compared to the C Zone graphs for several reasons. First, unlike the C Zone, water levels were rapidly dropping in most A Zone wells prior to the startup of Well 70. Due to the limited number of water levels collected within the A Zone prior to startup, we could not correct water level elevations in these shallow wells to counteract this declining antecedent trend. Second, very few A Zone wells are found in the downgradient portion of the TCE plume near Well 70, and several of the A Zone wells (both near Well 70 and the Hangar P3 source area) eventually went dry during the monitoring period. This limited the number of data points available to observe these log-linear relationships within the A/B Zone. Although the A/B Zone distance-drawdown graphs are not as reliable as the confined C Zone graphs, the A/B Zone graphs indicate that the cone of depression is significant and continued to expand throughout the monitoring period. After approximately 7 months of operation, water level data indicate that measurable drawdown in the A/B-Zone may be observed at a distance of over 10,000 feet from Well 70. We expect that with continued operation, the cone of depression will expand over time and the drawdown influence will increase until the well reaches equilibrium.

4.1.2.3 *Vertical Gradients*

Based on data collected during the RI, vertical gradients between various aquifer zones have generally been neutral (no vertical gradient) or slightly downward (although strong downward gradients have been observed near pumping wells such as the Fresno Adventist Academy wells).

Post-Well 70 startup vertical gradients were calculated for several well clusters across the site. In this section, we have presented data from the MWBP-05B/MWBP-05C/HFMW-05H well cluster (approximately 500 feet northeast of Well 70) because of its close proximity to Well 70 and its range of aquifer depths. The vertical gradients between MWBP-05B and MWBP-05C and between MWBP-05C and HFMW-05H are presented graphically on Figure 4-5. Also shown on this graph are the Well 70 flow rate and shutdown periods.

Figure 4-5 demonstrates that Well 70 greatly increases the vertical gradients between zones. The maximum A/B to C Zone vertical gradient during pumping was -0.09 ft/ft and the maximum C to H Zone vertical gradient during pumping was -0.04 ft/ft.

The observed downward gradients are consistent with ERM's hydrologic model of the Well 70 system, and are consistent with the observed deepening of the TCE plume near Well 70.

4.1.3 *Capture Zone Development*

Post-startup ground water elevation data were used to develop capture zone maps for the A/B and C aquifer zones (Figures 4-6 through 4-13). Four dates were selected to identify the capture analysis after the startup of Well 70:

- Startup — 25 January 1999
- Startup + 4 days — 29 January 1999
- Startup + 16 days — 10 February 1999
- Startup + 4 months — 28 May 1999

- Startup + 7 months 26 August 1999

Interpretation of the water level data was completed using kriging and surface vector computation techniques. Kriging is a mathematical process recognized by the USEPA as one of the best means for interpolation and extrapolation of measured data (USEPA, 1990). The ground water elevation data were kriged using the Environmental Visualization System (EVS) (C Tech Development Corporation, 1998) to produce a potentiometric water level surface that honors all of the measured data and interpolates areas with limited data with a high degree of accuracy.

The kriged potentiometric surfaces were contoured using 5-foot-contour intervals. Ground water flow "streamlines" were then calculated and plotted using a computer technique that analyzes the slope of the kriged water table surface within and between each grid cell, and computes and plots a vector in the downgradient flow direction. The calculated ground water flow streamlines are shown as thin green lines on each capture zone map. The extent of the capture zone was then delineated by drawing a line through the points furthest away from the extraction system from which flow vectors were directed back toward the extraction system. The capture zone extent is shown as a thick, green line on each map.

Water levels dropped below the bottom of several A Zone wells during the Well 70 startup monitoring period. Many of these A Zone wells were located upgradient of Well 70 near the Hangar P3 source area at OHF. To most accurately contour water level data for the May and October 1999 capture zone maps (after many of these wells went dry), water level elevations were estimated in dry wells by projecting the observed water level fluctuations in nearby (non-dry) A or B Zone wells onto the dry well's existing hydrograph. An example of this data projection technique is described on Figure 4-14. Similar water level projections were performed for selected A Zone wells near the Hangar P3 source area for the January and February 1999 capture zone maps. These were performed to fill in the data set where no water levels were measured. Even though water levels at these distant locations were not part of the scope of the monitoring program, they were later found to be beneficial to understanding the overall flow patterns across the site.

In addition, in areas away from the densely populated Well 70 monitoring well network, A/B Zone capture zone maps utilize some C Zone water level data, and conversely, the C Zone capture zone maps utilize some A and B Zone water level data. This is primarily due to the spatial availability of data; very few A/B Zone wells are installed downgradient of Well 70 (where the TCE plume is deeper), and very few C Zone wells are installed upgradient of Well 70 near the Hangar P3 source area (where the TCE plume is shallow). Water level data collected during the Area 1 RI show that only minor vertical head differences were observed between these zones at most well clusters across the site. Equating A and B Zone water levels with C Zone water levels is consistent with these previous observations and is therefore valid for estimating head values.

The results of this analysis show that the capture zones within the A/B and C Zones have grown over time due to ongoing pumping at Well 70. As water levels continue to drop, these capture zones will continue to grow. Figures 4-6 through 4-9 show the A/B aquifer capture zones relative to the TCE and PCE plumes in this zone. The August 1999 A/B aquifer capture zone map indicates that the capture zone is sufficient to capture the full width of both the TCE and PCE plumes. Figures 4-10 through 4-13 show the C aquifer capture zones relative to the TCE plume in this zone. Figures 4-12 and 4-13 show that the capture zone that was developed by May 1999 (4 months after startup of Well 70) is sufficient to capture the full width of the TCE plume. PCE is found in a small number of C-Zone wells, which are also within the C Zone capture zone. PCE is generally not found in the deeper aquifer zones.

4.2 *WATER QUALITY DATA*

Table 4-2 presents all compounds detected in water quality samples collected through January 2000 as part of the Well 70 IA. Eight of the A Zone monitoring wells went dry after pumping began in Well 70 (see Table 3-3); therefore, no water quality samples could be collected at these locations.

As presented in Section 1.4, the Well 70 IA ground water monitoring program was designed to study both the hydraulic and water quality effects of the restarting Well 70. As described above, the hydraulic effects were immediate, creating sufficient capture zones after only a few months of operation. Significant water quality effects, however, are expected to be observed downgradient of Well 70 over a longer period of time. The scope of water quality sampling performed as part of the Well 70 IA was designed to augment the Area 1 quarterly ground water monitoring program. No site-wide Area 1 sampling was performed, however, during the Well 70 IA monitoring program. Consequently, only limited water quality data are available for those wells positioned downgradient of the capture zone, such as HFMW-17C. Future ground water sampling is necessary to identify concentration trends in wells that are downgradient of the Well 70 capture zone.

TCE and PCE concentrations in monitoring wells near Well 70 (within the Well 70 capture zone) show mixed trends as summarized in the table below.

Contaminant	Concentration Changes in Wells	Wells
TCE	Increase in 3 wells	HFMW-09C MWBP-06C HFMW-26C
TCE	Decrease in 3 wells	HFMW-25C HFMW-28C MWBP-06B
TCE	Non-detect or no definable concentration trends in either direction in 5 wells	HFMW-25C HFMW-27A HFMW-27C MWBP-5B MWBP-05B
PCE	Increase in 2 wells	HFMW-28C MWBP-05C
PCE	Decrease in 1 well	HFMW-26C
PCE	Nondetect or no definable concentration trends in either direction in 8 wells	HFMW-09C HFMW-06B HFMW-27C MWBP-05B MWBP-06B MWBP-06C

Ground water extracted from Well 70 has also been monitored for potential VOC contamination. The only two significant contaminants of concern (COCs) are TCE and PCE. TCE and PCE concentration data for water entering Well 70's treatment system (referred to as "Well 70 influent") were provided by the City of Fresno and have been included on Table 4-2. Between 20 January 1999 and 2 September 1999, TCE has been detected in the Well 70 influent at concentrations that have ranged from 8.2 to 25 μg/L. All detected TCE concentrations have been greater than its MCL of 5 μg/L. PCE was not detected in the Well 70 influent during this monitoring period.

TCE concentrations in Well 70 influent are presented graphically on Figure 4-15. As shown on this figure, TCE concentrations steadily increased from the time of Well 70 startup until mid-June, when they appear to plateau. TCE concentrations increased from a minimum of 8.2 µg/L to a maximum of 25 µg/L, and have recently ranged between 15 and 25 µg/L.

Although evaluating the treatment system performance is not part of the scope of the Well 70 IA monitoring program, treated water from Well 70 has consistently resulted in a non-detect reading for all sampling. The City of Fresno Water Division continues to sample Well 70 influent (intake) and effluent (discharge) samples in accordance with California Department of Health Services requirements.

5.0 CONCLUSIONS

Water level measurements collected since January 1999 demonstrate that Well 70's approximate 2,000-gpm discharge exerts an extremely strong influence on water levels throughout the study area. Ground water elevations in wells surrounding Well 70 decreased at a relatively steady rate through the end of the monitoring period (August 1999). Pumping-induced drawdown in the aquifer zones studied (primarily the combined A/B Zone and the C Zone) has resulted in increased horizontal and vertical gradients surrounding Well 70, which has created expanding capture zones within these aquifers. These field observations are consistent with ERM's hydrologic model of the Well 70 system, and are consistent with the observed deepening of the TCE plume near Well 70.

The August 1999 A/B Zone capture zone map indicates that the capture zone is sufficient to capture the full width of the TCE and PCE plumes. The August 1999 C Zone capture zone map indicates that the capture zone is sufficient to capture the full width of the TCE plume. Hydrologic data indicate that the capture zones had not reached steady state as of August 1999, and that the capture zones will continue to expand until sufficient recharge to these aquifers is achieved.

The water quality data collected as part of the Well 70 IA indicate that ground water extraction has caused minor chemical fluctuations in wells located within the Well 70 capture zone. TCE concentrations in water extracted from Well 70 gradually increased during the first 6 months of operation, but have generally stabilized at concentrations ranging from 15 to 25 µg/L. Additional ground water quality monitoring will be required to identify long-term chemical data trends downgradient of the Well 70 capture zones.

These water level and ground water chemistry data will be incorporated into the OHF ground water model, which will be used in the Area 1 FS to evaluate potential ground water extraction scenarios.

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Table 3-1
Well Construction Details
Well 70 Interim Action
Fresno, California

Well Identification	Drilling End Date	Coordinates X	Coordinates Y	Top of Casing Elevation (feet msl)	Boring Total Depth (feet bgs)	Casing Total Depth (feet bgs)	Casing Diameter (inches)	Screen Interval (feet bgs)	Top of Filter Pack (feet bgs)
HFMW-09C	1/20/1998	6351152.83	2162662.34	320.61	158	155.5	4	145.0-155.0	142.0
HFMW-24A	1/21/1998	6351362.41	2162224.07	321.23	103	100.0	4	79.5-99.5	76.5
HFMW-25A	1/28/1998	6351214.25	2162091.72	319.71	103	100.0	4	79.5-99.5	-
HFMW-25C	1/24/1998	6351214.3	2162101.7	319.75	165	155.5	4	145.0-155.0	142.0
HFMW-26C	2/11/1998	6351851.85	2162094.98	320.59	165	155.5	4	145.0-155.0	140.0
HFMW-27A	2/4/1998	6351897.53	2161663.63	319.97	103	100.5	4	80.0-100.0	-
HFMW-27C	2/3/1998	6351905.93	2161663.19	320.02	170	151.5	4	141.0-151.0	134.0
HFMW-28C	2/9/1998	6353058.97	2162489.65	321.31	165	148.5	4	138.0-148.0	133.0

Notes:

Coordinates in US Feet
msl = mean sea level
bgs = below ground surface

Table 3-2
Water Level Monitoring Program Summary
Well 70 Interim Action
Fresno, California

Well Designation	Aquifer Zone	Distance from Well 70 (feet)	Screen (Feet BGS)	LT Pre-Startup[1] 6/18/98 to 1/13/99	ST Pre-Startup[2] 1/14/99 to 1/25/99	Startup Monitoring[3] 1/25/99 to 2/18/99	LT Monitoring[4] 2/18/99 to 8/26/99
A/B Zone Wells							
HFMW-24A	A	34.30	79.5-99.5		DL/ML	DL/ML	DL/ML
HFMW-25A	A	230.00	79.5-99.5		DL/ML	DL/ML	DL/ML
MWBP-05A	A	454.70	73-93		DL/ML	DL/ML	DL/ML
HFMW-09A	A	459.00	79-99		DL/ML	DL/ML	DL/ML
MWBP-05B	B	546.08	106-116		DL/ML	DL/ML	DL/ML
HFMW-27A	A	789.60	80-100		DL/ML	DL/ML	DL/ML
MWBP-11	A	869.80	74-94		ML	ML	ML
MWBP-12	A	890.40	72-92		ML	ML	ML
MWBP-06A	A	1146.70	73-93		DL/ML	DL/ML	DL/ML
MWBP-06B	B	1171.10	104-114		DL/ML	DL/ML	DL/ML
MW2-01	A	1223.70	73-93		ML	ML	ML
MWBP-10	A	1507.30	71-91		ML	ML	ML
MWBP-07	A	1545.60	71-91		DL/ML	DL/ML	DL/ML
HFMW-10A	A	1583.60	78-98		ML	ML	ML
MW5-01	A	1587.30	72-92		ML	ML	ML
MW5-01B	B	1622.00	108-118			ML	ML
MWBP-08	A	1975.00	69-95		DL/ML	DL/ML	DL/ML
MWBP-09A	A	2492.90	74-94				ML
MWBP-09B	B	2503.20	101-116				ML
HFMW-11A	A	3335.04	78-98				ML
HFMW-14A	A	3516.00	77-97				ML
HFMW-08A	A	3618.60	78-98				ML
MW4-02	A	3765.20	71-91				ML
MW1-02	A	3935.00	71-91		ML	ML	ML
HFMW-13A	A	4836.90	77-97				ML
HFMW-07A	A	4846.90	75-95				ML
HFMW-12A	A	4956.86	76-96				ML
HFMW-15A	A	5279.60	74-94				ML
HFMW-20A	A	5343.20	79.5-99.5				ML
HFMW-06A	A	5774.80	76-96				ML
HFMW-16A	A	6004.90	75-95				ML
C Zone Wells							
HFMW-25C	C	222.90	145-155	DL	DL/ML	DL/ML	DL/ML
HFMW-09C	C	463.30	145-155	DL	DL/ML	DL/ML	DL/ML
MWBP-05C	C	485.30	139-149		DL/ML	DL/ML	DL/ML
HFMW-26C	C	503.00	145-155	DL	DL/ML	DL/ML	DL/ML
HFMW-27C	C	795.50	141-151	DL	DL/ML	DL/ML	DL/ML
MWBP-06C	C	1116.20	136-146		DL/ML	DL/ML	DL/ML
MW5-01C	C	1581.30	136-146			ML	ML
HFMW-28C	C	1699.80	138-148	DL	DL/ML	DL/ML	DL/ML
HFMW-17C	C	1998.90	148-158		ML	ML	ML
HFMW-22C	C	2412.90	145-155		ML	ML	ML
MWBP09C	C	2481.20	132-148				ML
HFMW-18C	C	2820.40	150-160		DL/ML	DL/ML	DL/ML
Deeper Zone Wells							
HFMW-22E	E	2428.40	230-240		ML	ML	ML
HFMW-05H	H	566.50	335-345		DL/ML	DL/ML	DL/ML

Notes:

[1] Long Term Pre-Startup monitoring (electronic dataloggers recorded 12-hour readings).

[2] Short Term Pre-Startup monitoring (electronic dataloggers recorded 10-minute readings).

[3] Startup monitoring (electronic dataloggers recorded logarithmic readings).

[4] Long-term monitoring (electronic dataloggers continued recording at logarithmic intervals).
Well 70 was started on 1/25/99 at 1400 hours following water level collection, restarted on 2/18/99 @ 14:07.

DL = Datalogger.

ML = Manual water level.

Table 3-3

Ground Water Quality Monitoring Program Summary
Well 70 Interim Action
Fresno, California

Well Designation	Aquifer Zone	Well Screen Interval (Feet BGS)	Approximate Months Before (-) or After Well 70 Startup						
			-10	-7	2	4	7	10	12
Date Sampled			3/23/98 to 3/26/98	6/19/98 to 6/25/98	3/22/99 to 3/23/99	6/1/99 to 6/4/99	8/30/99 to 9/1/99	12/3/99	1/17/00 to 1/18/00
High Frequency/12 Month Group									
HFMW-24A	A	70-100	X	X	Dry	Dry	Dry	Dry	Dry
HFMW-25A	A	70-100	X	X	X	Dry	Dry	Dry	Dry
HFMW-25C	C	145-160	X*	X	X	X	X	X	X
MWBP-05C	C	139-149		X**	X	X	X	X	X
Low Frequency/6 Month/New Well Group									
HFMW-27A	A	70-100	X	X		X	Dry		
HFMW-9C	C	145-160	X	X		X	X		
HFMW-26C	C	145-160	X	X		X	X		X
HFMW-27C	C	145-160	X	X		X	X		
HFMW-28C	C	145-160	X	X		X	X		
HFMW-17C	C	148-158							X
Low Frequency/6 Month/Existing Well Group									
HFMW-9A	A	79-99		X		Dry	Dry		
MWBP-05A	A	73-93		X**		Dry	Dry		
MWBP-06A	A	73-93		X		Dry	Dry		
MWBP-07	A	71-91		X		Dry	Dry		
MWBP-08	A	69-95		X		Dry	Dry		
MWBP-05B	B	106-116		X		X	X		
MWBP-06B	B	104-114		X		X	X		
MWBP-06C	C	136-146		X		X	X		

Notes:
X = VOC sample collected.
* HFMW-25C also sampled on 7 April 1998.
** Wells sampled 10 June 1998 as part of OHF Second Quarter sampling round.

Table 4-1
Manual Ground Water Level Monitoring Data
Well 70 Interim Action
Fresno, California

Well Designation	Aquifer Zone	Distance from Well 70 (feet)	Screen (Feet BGS)	Elevation	Corrected Elevation[1]	LT Pre DL[2] GW Elevation 4/19/1999	DTW 5/28/1999	GW Elevation 5/28/1999	DTW 7/15/1999	GW Elevation 7/15/1999	DTW 8/26/1999	GW Elevation 8/26/1999
A/B Zone Wells												
HFMW-24A	A	34.30	79.5-99.5	321.23	321.26	221.79*	dry	219.63*	dry	218.49*	dry	216.33*
HFMW-25A	A	230.00	79.5-99.5	319.71	319.75	220.66	dry	218.49*	dry	217.36*	dry	215.20*
MWBP-05A	A	454.70	73-93	320.04	320.11	225.59*	dry	223.42*	dry	222.29*	dry	220.13*
HFMW-09A	A	459.00	79-99	320.62	320.73	222.42	dry	220.25*	dry	219.12*	dry	216.96*
MWBP-05B	B	546.08	106-116	319.8	319.88	225.32	96.65	223.15	97.78	222.02	99.94	219.86
HFMW-27A	A	789.60	80-100	319.97	320.01	225.24	97.09	222.88	dry	221.75*	dry	219.59*
MWBP-11	A	869.80	74-94	321.76		226.26*	dry	224.09*	dry	222.96*	dry	220.80*
MWBP-12	A	890.40	72-92	320.48		227.61*	dry	225.55*	dry	223.91*	dry	222.41*
MWBP-06A	A	1146.70	73-93	321	321.09	229.12	dry	227.05*	dry	225.42*	dry	223.92*
MWBP-06B	B	1171.10	104-114	320.84	320.93	229.81	93.09	227.75	94.73	226.11	96.23	224.61
MW2-01	A	1223.70	73-93	322.02		228.57*	dry	226.62*	dry	224.91*	dry	223.25*
MWBP-10	A	1507.30	71-91	323.68		229.21*	dry	227.25*	dry	225.55*	dry	223.88*
MWBP-07	A	1545.60	71-91	320.87	320.93	232.39	90	230.93	dry	229.30*	dry	227.80*
HFMW-10A	A	1583.60	78-98	323.27		227.79*	dry	225.84*	dry	224.13*	dry	222.47*
MW5-01	A	1587.30	72-92	322.19		230.51*	dry	228.56*	dry	226.85*	dry	225.19*
MW5-01B	B	1622.00	108-118	321.91		230.39	93.47	228.44	95.18	226.73	96.84	225.07
MWBP-08	A	1975.00	69-95	321.73	321.80	231.35*	dry	229.29*	dry	227.65*	dry	226.15*
MWBP-09A	A	2492.90	74-94	324.58		234.21	dry		dry		dry	
MWBP-09B	B	2503.20	101-116	324.36		234.23	91.8	232.56	NM		NM	
HFMW-11A	A	3335.04	78-98	326.84		235.95	92.52	234.32	NM	232.30*	dry	231.63*
HFMW-14A	A	3516.00	77-97	327.17		237.21	91.16	236.01	NM	234.61*	NM	233.81*
HFMW-08A	A	3618.60	78-98	327.4		237.26	91.22	236.18	NM		94.55	232.85
MW4-02	A	3765.20	71-91	327.06			dry		dry		dry	
MW1-02	A	3935.00	71-91	327.68		238.08*	dry	237.54*	dry	236.15*	dry	235.34*
HFMW-13A	A	4836.90	77-97	330.93		241.36	90.26	240.67	92.28	238.65	92.95	237.98
HFMW-07A	A	4846.90	75-95	328.53		242.11	87.05	241.48	88.56	239.97	89.45	239.08
HFMW-12A	A	4956.86	76-96	331.64		239.88	92.61	239.03	dry	237.01*	dry	236.34*
HFMW-15A	A	5279.60	74-94	331.82			dry		dry		dry	
HFMW-20A	A	5343.20	79.5-99.5	330.64		244.77	86.41	244.23	87.8	242.84	88.61	242.03
HFMW-06A	A	5774.80	76-96	332.19		244.01	88.65	243.54	90.4	241.79	91.06	241.13
HFMW-16A	A	6004.90	75-95	332.86		243.95	89.25	243.61	91.14	241.72	91.75	241.11
C Zone Wells												
HFMW-25C	C	222.90	145-155	319.75	NA	219.92	101.71	218.04	103.1	216.65	105.48	214.27
HFMW-09C	C	463.30	145-155	320.67	NA	222.19	100.43	220.24	101.81	218.86	104.04	216.63
MWBP-05C	C	485.30	139-149	319.57	319.70	223.55	98.1	221.47	99.66	219.91	101.78	217.79
HFMW-26C	C	503.00	145-155	320.59	NA	223.39	99.25	221.34	101.1	219.49	103.22	217.37
HFMW-27C	C	795.50	141-151	320.02	NA	223.75	98.31	221.71	100.47	219.55	102.68	217.34
MWBP-06C	C	1116.20	136-146	320.56	320.65	227.66	94.8	225.76	96.82	223.74	98.64	221.92
MW5-01C	C	1581.30	136-146	322.61		229.58	94.94	227.67	96.73	225.88	98.42	224.19
HFMW-28C	C	1699.80	138-148	321.31	NA	230.34	92.85	228.46	95.03	226.28	96.62	224.69
HFMW-17C	C	1998.90	148-158	316.49		223.28	95.05	221.44	97.19	219.3	99.73	216.76
HFMW-22C	C	2412.90	145-155	322.93		229.09	95.47	227.46	98.16	224.77	99.95	222.98
MWBP09C	C	2481.20	132-148	324.29		234.19	91.8	232.49	93.7	230.59	95.1	229.19
HFMW-18C	C	2820.40	150-160	314.96	314.96	223.76	92.75	222.21	94.91	220.05	96.95	218.01
Deeper Zone Wells												
HFMW-22E	E	2428.40	230-240	323.02		227.1	100.43	222.59	102.45	220.57	109.35	213.67
HFMW-05H	H	566.50	335-345	320.45	320.60	217.84	104.69	215.76	107.21	213.24	109.11	211.34

Notes:
[1] Well head elevations were corrected due to addition of caps to support dataloggers
[2] Long Term Pre-Startup monitoring using electronic dataloggers (12-hour readings
[3] Short Term Pre-Startup monitoring using electronic dataloggers (10-minute readin
[4] Startup monitoring using electronic dataloggers (logarithmic readings 1/25/99 thr
* Estimated ground water elevation, projected from slope of ground water measuren
** Could not measure because water is below the top of the datalogger.
Well 70 was started on 1/25/99 at 1400 hours following water level collection, rest
NA = Not Applicable.
NM = Not Measured.
dry = water level below bottom of well.

Sample Location	Date Sampled	Screened Interval (feet bgs)	TCE	PCE	BF	BM	CCL	CF	CM	DBCM	C-1,2-DCE	DCM	1,2-DCP	Freon 113	TOL
	Maximum Contaminant Level:		5	5	100	N/A	0.5	100	N/A	100	6	5	5	1200	150
HFMW-09A	6 Mar 98	79-99	< 0.5	< 0.5	< 1	< 1	< 0.5	< 0.5	0.71 U	< 0.5	< 0.5	< 1	< 0.5	na	< 0.5
HFMW-09A	12 Jun 98	79-99	< 0.5	< 0.5	< 1	< 1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 1	< 0.5	na	< 0.5
HFMW-09A	11 Sep 98	79-99	< 0.5	< 0.5	< 1	< 1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 1	< 0.5	na	< 0.5
HFMW-09A	14 Dec 98	79-99	< 0.5	< 0.5	< 1	< 1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.8 j	< 0.5	na	< 0.5
HFMW-09C	23 Mar 98	145-155	0.23 j	< 0.5	< 1	< 1	< 0.5	< 0.5	0.43 Uj	< 0.5	< 0.5	< 1	< 0.5	na	< 0.5
HFMW-09C	22 Jun 98	145-155	0.41 j	< 0.5	< 5	< 1	< 0.5	< 0.5	< 1	< 0.5	< 0.5	< 1	< 0.5	< 1	na
HFMW-09C	1 Jun 99	145-155	3	< 1	< 5	< 1	< 0.5	< 1	< 1	< 1	< 1	< 5	0.2 j	< 1	na
HFMW-09C	31 Aug 99	145-155	1.7	< 1	< 1	< 1	< 0.5	< 1	< 1	< 1	< 1	< 1	< 1	na	na
HFMW-17C	16 Dec 97	149	3.8	< 0.5	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 5	< 0.5	na	na
HFMW-17C (dup)	16 Dec 97	149	4.1	< 0.5	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 5	< 0.5	na	na
HFMW-17C	17 Dec 97	170	21	< 0.5	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 5	2.6	na	na
HFMW-17C	23 Dec 97	148-158	3	< 0.5	< 5	< 5	< 0.5	< 0.5	< 5	< 1	na	< 5	0.12 j	na	na
HFMW-17C	30 Mar 98	148-158	5.4	< 0.5	< 1	< 1	< 0.5	< 0.5	0.42 j	< 0.5	< 0.5	< 1	0.38 j	na	< 0.5
HFMW-17C	10 Jun 98	148-158	4.4	< 0.5	< 1	< 1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 1	0.21 j	na	< 0.5
HFMW-17C	15 Sep 98	148-158	3.3	< 0.5	< 1	< 1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 1	0.1 j	na	< 0.5
HFMW-17C	17 Jan 00	148-158	7.4	< 1	< 1	< 1	< 0.5	< 1	< 1	< 1	< 1	< 1	0.2 j	< 2	< 1
HFMW-21C	31 Mar 98	145-155	10	< 0.5	< 1	< 1	< 0.5	< 0.5	0.83 U	< 0.5	< 0.5	< 1	0.6	na	0.42 j
HFMW-21C	3 Jun 98	145-155	12	0.16 j	< 1	< 1	< 0.5	0.13 U	< 0.5	< 0.5	< 0.5	< 1	0.6	na	< 0.5
HFMW-21C	17 Sep 98	145-155	8.3	0.15 j	< 1	< 1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 1	0.57	na	< 0.5
HFMW-21C*	18 Jan 00	145-155	9.2	0.42 j	< 1	< 1	< 0.5	< 1	< 1	< 1	< 1	< 1	0.54 j	< 2	< 0.5
HFMW-24A	27 Mar 98	79.5-99.5	< 0.5	< 0.5	< 1	< 1	< 0.5	< 0.5	0.76 U	< 0.5	< 0.5	< 1	< 0.5	na	< 0.5
HFMW-24A	23 Jun 98	79.5-99.5	< 0.5	< 0.5	< 5	< 1	< 0.5	< 0.5	< 1	< 0.5	< 0.5	< 1	< 0.5	0.26 j	na
HFMW-25A	23 Mar 98	79.5-99.5	1	0.47 j	< 1	< 1	< 0.5	< 0.5	0.4 Uj	< 0.5	< 0.5	< 1	< 0.5	na	< 0.5
HFMW-25A	19 Jun 98	79.5-99.5	0.85	0.42 j	< 5	0.12 j	< 0.5	< 0.5	< 1	< 0.5	< 0.5	< 1	< 0.5	< 1	na
HFMW-25A	23 Mar 99	79.5-99.5	0.6 j	0.33 j	< 5	< 1	< 0.5	< 1	< 1	< 1	0.22 j	< 5	0.2 j	0.26 j	na
HFMW-25C	23 Mar 98	145-155	1.8	< 0.5	< 1	< 1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 1	< 0.5	na	< 0.5
HFMW-25C	7 Apr 98	145-155	7.5	< 0.5	< 1	< 1	< 0.5	< 0.5	0.56	< 0.5	< 0.5	< 1	0.52	na	< 0.5
HFMW-25C (dup)	7 Apr 98	145-155	6.9	< 0.5	< 1	< 1	< 0.5	< 0.5	0.55	< 0.5	< 0.5	< 1	0.49 j	na	< 0.5
HFMW-25C	19 Jun 98	145-155	4	< 0.5	< 5	0.13 j	0.16 j	< 0.5	< 1	< 0.5	< 0.5	0.15 j	0.3 j	< 1	na
HFMW-25C (dup)	19 Jun 98	145-155	4.1	< 0.5	< 5	0.19 j	0.16 j	< 0.5	< 1	< 0.5	< 0.5	< 1	0.32 j	< 1	na
HFMW-25C	22 Mar 99	145-155	3.3	< 1	< 5	< 1	0.21 j	< 1	< 1	< 1	< 1	< 5	0.34 j	< 1	na
HFMW-25C	1 Jun 99	145-155	3.9	< 1	< 5	< 1	< 0.5	< 1	< 1	< 1	< 1	< 5	0.34 j	< 1	na
HFMW-25C (dup)	1 Jun 99	145-155	3.8	< 1	< 5	< 1	< 0.5	< 1	< 1	< 1	< 1	< 5	0.33 j	< 1	na
HFMW-25C	31 Aug 99	145-155	4.5	< 1	< 1	< 1	< 0.5	< 1	< 1	< 1	< 1	< 1	0.32 j	na	na
HFMW-25C	3 Dec 99	145-155	4.2	< 1	< 1	< 1	< 0.5	< 1	< 1	< 1	< 1	< 1	< 1	< 2	< 1
HFMW-25C	17 Jan 00	145-155	4.3	< 1	< 1	< 1	< 0.5	< 1	< 1	< 1	< 1	< 1	0.37 j	< 2	< 1
HFMW-26C	26 Mar 98	145-155	92	27	< 5	< 5	< 2.5	< 2.5	< 2.5	< 2.5	2.7	< 5	2.5	na	< 2.5
HFMW-26C	23 Jun 98	145-155	53	18	< 5	< 1	< 0.5	0.44 j	< 1	< 0.5	1.8	< 1	2.1	< 1	na
HFMW-26C	4 Jun 99	145-155	200	3 j	< 50	< 10	< 5	< 10	< 10	< 10	1.6 j	< 50	1.8 j	< 10	na
HFMW-26C	1 Sep 99	145-155	300	< 10	< 10	< 10	< 5	< 10	< 10	< 10	1.5 j	< 10	< 10	na	na
HFMW-26C	18 Jan 00	145-155	320	< 10	< 10	< 10	< 5	< 10	< 10	< 10	1.7 j	< 10	1.7 j	< 20	< 10
HFMW-26C	18 Jan 00	145-155	320	< 10	< 10	< 10	< 5	< 10	< 10	< 10	1.6 j	< 10	< 10	< 20	< 10
HFMW-27A	27 Mar 98	80-100	< 0.5	< 0.5	< 1	< 1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 1	< 0.5	na	0.21 j
HFMW-27A	19 Jun 98	80-100	< 0.5	< 0.5	< 5	< 1	< 0.5	< 0.5	< 1	< 0.5	< 0.5	< 1	< 0.5	< 1	na
HFMW-27A	3 Jun 99	80-100	< 1	< 1	< 5	< 1	< 0.5	< 1	< 1	< 1	< 1	< 5	< 1	< 1	na
HFMW-27C	27 Mar 98	141-151	9.5	8.5	< 1	< 1	< 0.5	< 0.5	0.58 U	< 0.5	0.7	< 1	1.5	na	< 0.5
HFMW-27C	19 Jun 98	141-151	7.2	8.4	< 5	< 1	< 0.5	< 0.5	< 1	< 0.5	0.47 j	< 1	1.2	< 1	na
HFMW-27C	1 Jun 99	141-151	9.6	8.2	< 5	< 1	< 0.5	< 1	< 1	< 1	0.58 j	< 5	1.1	< 1	na
HFMW-27C	31 Aug 99	141-151	11	7.6	< 1	< 1	< 0.5	< 1	< 1	< 1	0.48 j	< 1	1.2	na	na
HFMW-28C	27 Mar 98	138-148	14	0.98	< 1	< 1	< 0.5	< 0.5	0.37 Uj	< 0.5	0.91	< 1	1.2	na	< 0.5
HFMW-28C	19 Jun 98	138-148	17	0.99	< 5	< 1	< 0.5	0.21 j	< 1	< 0.5	1.1	< 1	1	< 1	na

Sample Location	Date Sampled	Screened Interval (feet bgs)	TCE	PCE	BF	BM	CCL	CF	CM	DBCM	C-1,2-DCE	DCM	1,2-DCP	Freon 113	TOL
		Maximum Contaminant Level:	**5**	**5**	**100**	**N/A**	**0.5**	**100**	**N/A**	**100**	**6**	**5**	**5**	**1200**	**150**
HFMW-28C	3 Jun 99	138-148	9.7	1.2	< 5	< 1	< 0.5	0.21 j	< 1	< 1	1.1	< 5	1	< 1	na
HFMW-28C	31 Aug 99	138-148	5.5	2.1	< 1	< 1	< 0.5	< 1	< 1	< 1	1.7	< 1	0.84 j	na	na
MWBP-05A	10 Jun 98	73.1-93.1	20	9.5	< 1	< 1	0.11 j	0.29 j	< 0.5	< 0.5	1.4	< 1	0.95	na	< 0.5
MWBP-05A	29 Sep 98	73.1-93.1	19	4.8	< 1	< 1	0.11 j	0.2 j	< 0.5	< 0.5	0.76	< 1	0.93	na	< 0.5
MWBP-05A	23 Dec 98	73.1-93.1	23	5	< 1	< 1	0.13 j	0.19 j	< 0.5	< 0.5	0.6	0.37 j	1.1	na	0.15 j
MWBP-05B	23 Jun 98	106-116	48	22	< 5	< 1	< 0.5	0.38 j	< 1	< 0.5	1.3	< 1	1.2	< 1	na
MWBP-05B (dup)	23 Jun 98	106-116	50	23	< 5	< 1	< 0.5	0.33 j	< 1	< 0.5	1.2	< 1	1.2	< 1	na
MWBP-05B	4 Jun 99	106-116	42	17	< 5	< 1	< 0.5	0.28 j	< 1	< 1	1.2	< 5	0.89 j	< 1	na
MWBP-05B (dup)	4 Jun 99	106-116	43	17	< 5	< 1	< 0.5	0.28 j	< 1	< 1	1.1	< 5	0.92 j	< 1	na
MWBP-05B	30 Aug 99	106-116	55	33	< 2	< 2	< 1	< 2	< 2	< 2	3.2	< 2	1.1 j	na	na
MWBP-05C	8 Apr 98	139.2-149.2	94	0.96 j	< 5	< 5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 5	2.7	na	< 2.5
MWBP-05C	10 Jun 98	139.2-149.2	57	0.55 j	< 2	< 2	0.6 j	< 1	< 1	< 1	< 1	< 2	1.8	na	< 1
MWBP-05C (dup)	10 Jun 98	139.2-149.2	53	0.58 j	< 2	< 2	0.63 j	< 1	< 1	< 1	< 1	< 2	1.7	na	< 1
MWBP-05C	29 Sep 98	139.2-149.2	47 J	0.7 j	< 2	< 2	0.47 j	0.27 j	< 1	< 1	< 1	< 2	2.1	na	< 1
MWBP-05C (dup)	29 Sep 98	139.2-149.2	51	0.79 j	1.2 j	< 2	0.48 j	0.3 j	< 1	< 1	< 1	< 2	2.3	na	< 1
MWBP-05C	23 Dec 98	139.2-149.2	31	0.5	< 1	< 1	0.29 j	0.23 j	< 0.5	< 0.5	< 0.5	0.7 j	2	na	0.13 j
MWBP-05C (dup)	23 Dec 98	139.2-149.2	30	0.46 j	< 1	< 1	0.29 j	0.22 j	< 0.5	< 0.5	< 0.5	0.71 j	2	na	0.15 j
MWBP-05C	22 Mar 99	139.2-149.2	26	0.41 j	< 5	< 1	0.3 j	0.26 j	< 1	0.29 j	0.22 j	< 5	1.7	< 1	na
MWBP-05C (dup)	22 Mar 99	139.2-149.2	26	0.42 j	< 5	< 1	0.3 j	0.25 j	< 1	0.3 j	0.22 j	< 5	1.7	< 1	na
MWBP-05C	4 Jun 99	139.2-149.2	26	0.62 j	< 5	< 1	0.19 j	0.24 j	< 1	< 1	< 1	< 5	1.7	< 1	na
MWBP-05C	30 Aug 99	139.2-149.2	55	27	< 2	< 2	< 1	< 2	< 2	< 2	1.3 j	< 2	1.5 j	na	na
MWBP-05C (dup)	30 Aug 99	139.2-149.2	57	27	< 2	< 2	< 1	< 2	< 2	< 2	1.3 j	< 2	1.6 j	na	na
MWBP-05C	3 Dec 99	139.2-149.2	40	35	< 5	< 5	< 2.5	< 5	< 5	< 5	< 5	< 5	< 5	< 10	< 5
MWBP-05C	17 Jan 00	139.2-149.2	35	28	< 2	< 2	< 1	< 2	< 2	< 2	1.4 j	< 2	0.93 j	< 4	< 2
MWBP-06A	22 Jun 98	73.5-93.5	< 0.5	5.1	< 5	< 1	< 0.5	< 0.5	< 1	< 0.5	< 0.5	< 1	< 0.5	< 1	na
MWBP-06B	22 Jun 98	104-114	1.5	7.5	< 5	< 1	< 0.5	< 0.5	< 1	< 0.5	< 0.5	< 1	< 0.5	< 1	na
MWBP-06B	2 Jun 99	104-114	0.36 j	4.8	< 5	< 1	< 0.5	< 1	< 1	< 1	< 1	< 5	< 1	< 1	na
MWBP-06B	1 Sep 99	104-114	0.68 j	5.7	< 1	< 1	< 0.5	< 1	< 1	< 1	< 1	< 1	< 1	na	na
MWBP-06C	22 Jun 98	136.5-146.5	120	< 1	< 10	< 2	< 1	0.33 j	< 2	< 1	0.74 j	< 2	< 1	< 2	na
MWBP-06C	2 Jun 99	136.5-146.5	150	< 10	< 50	< 10	< 5	< 10	< 10	< 10	< 10	< 50	< 10	< 10	na
MWBP-06C	1 Sep 99	136.5-146.5	170	< 10	< 10	< 10	< 5	< 10	< 10	< 10	< 10	< 10	< 10	na	na
MWBP-07	17 Mar 98	71-91	0.24 j	0.94	< 1	< 1	< 0.5	< 0.5	0.75 U	< 0.5	< 0.5	< 1	< 0.5	na	< 0.5
MWBP-07	16 Jun 98	71-91	< 0.5	0.66	< 1	< 1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 1	< 0.5	na	< 0.5
MWBP-07	28 Sep 98	71-91	< 0.5	0.49 j	< 1	< 1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 1	< 0.5	na	< 0.5
MWBP-07	18 Dec 98	71-91	< 0.5	0.69	< 1	< 1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6 j	< 0.5	na	0.14 j
MWBP-08	23 Jun 98	73-93	< 0.5	0.43 j	< 5	< 1	< 0.5	< 0.5	< 1	< 0.5	< 0.5	< 1	< 0.5	< 1	na
Well 70 Influent	20 Jan 99	Total Depth = 400	8.2	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	29 Jan 99	Total Depth = 400	10	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	2 Feb 99	Total Depth = 400	11	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	9 Feb 99	Total Depth = 400	11	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	22 Feb 99	Total Depth = 400	11	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	24 Feb 99	Total Depth = 400	12	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	9 Mar 99	Total Depth = 400	12	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	15 Mar 99	Total Depth = 400	13	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	22 Mar 99	Total Depth = 400	13	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	2 Apr 99	Total Depth = 400	14	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	9 Apr 99	Total Depth = 400	15	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	15 Apr 99	Total Depth = 400	15	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	19 Apr 99	Total Depth = 400	19	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	30 Apr 99	Total Depth = 400	19	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	7 May 99	Total Depth = 400	18	< 0.5	-	-	-	-	-	-	-	-	-	-	-

Sample Location	Date Sampled	Screened Interval (feet bgs)	TCE	PCE	BF	BM	CCL	CF	CM	DBCM	C-1,2-DCE	DCM	1,2-DCP	Freon 113	TOL
		Maximum Contaminant Level:	**5**	**5**	**100**	**N/A**	**0.5**	**100**	**N/A**	**100**	**6**	**5**	**5**	**1200**	**150**
Well 70 Influent	10 May 99	Total Depth = 400	**19**	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	20 May 99	Total Depth = 400	**20**	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	28 May 99	Total Depth = 400	**23**	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	3 Jun 99	Total Depth = 400	**22**	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	10 Jun 99	Total Depth = 400	**23**	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	14 Jun 99	Total Depth = 400	**22**	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	29 Jun 99	Total Depth = 400	**20**	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	8 Jul 99	Total Depth = 400	**25**	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	13 Jul 99	Total Depth = 400	**21**	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	21 Jul 99	Total Depth = 400	**21**	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	28 Jul 99	Total Depth = 400	**21**	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	5 Aug 99	Total Depth = 400	**20**	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	9 Aug 99	Total Depth = 400	**22**	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	18 Aug 99	Total Depth = 400	**15**	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	23 Aug 99	Total Depth = 400	**17**	< 0.5	-	-	-	-	-	-	-	-	-	-	-
Well 70 Influent	2 Sep 99	Total Depth = 400	**21**	< 0.5	-	-	-	-	-	-	-	-	-	-	-

Notes:
Concentrations are reported in micrograms per liter (µg/L)
Compounds not detected are not reported
Well 70 data provided by the City of Fresno (TCE and PCE data only)
Compounds analyzed for but not detected (except as described below*) include: bromodichloromethane, benzene, chlorobenzene, chloroethane, 1,1-dichloroethane, 1,2-dichloroethane, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, dichlorodifluoromethane, 1,1-dichloroethene, trans-1,2-dichloroethene, cis-1,3-dichloropropane, trans-1,3-dichloropropane, ethylbenzene, 1,1,2,2-tetrachlorothane, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichlorofluoromethane, vinyl chloride, and xylenes.
* HFMW-21C sample also contained 1.1 µg/L of 1,1-dichloroethene. This compound was not detected in other samples.

Key:
(dup) = Duplicate sample
< = Less than; compound not detected at method detection limit
na = Not analyzed
N/A = Information not available
Shading indicates exceedance of maximum contaminant level
- Information not provided to ERM

ERM Qualifiers:
J = Detected concentrations are considered estimated
U = The analyte was analyzed for; the reported concentration should be considered not detected above the reported sample value

Laboratory Qualifier:
j = Value is between the method detection limit and the practical quantitation limit

CHEMICAL ABBREVIATIONS

Abbreviation	Compound	Abbreviation	Compound
BF	Bromoform	C-1,2-DCE	cis-1,2-Dichloroethene
BM	Bromomethane	DCM	Methylene chloride
CCL	Carbon tetrachloride	1,2-DCP	1,2-Dichloropropane
CF	Chloroform	Freon 113	Trichlorotrifluoroethane
CM	Chloromethane	TOL	Toluene
DBCM	Dibromochloromethane		

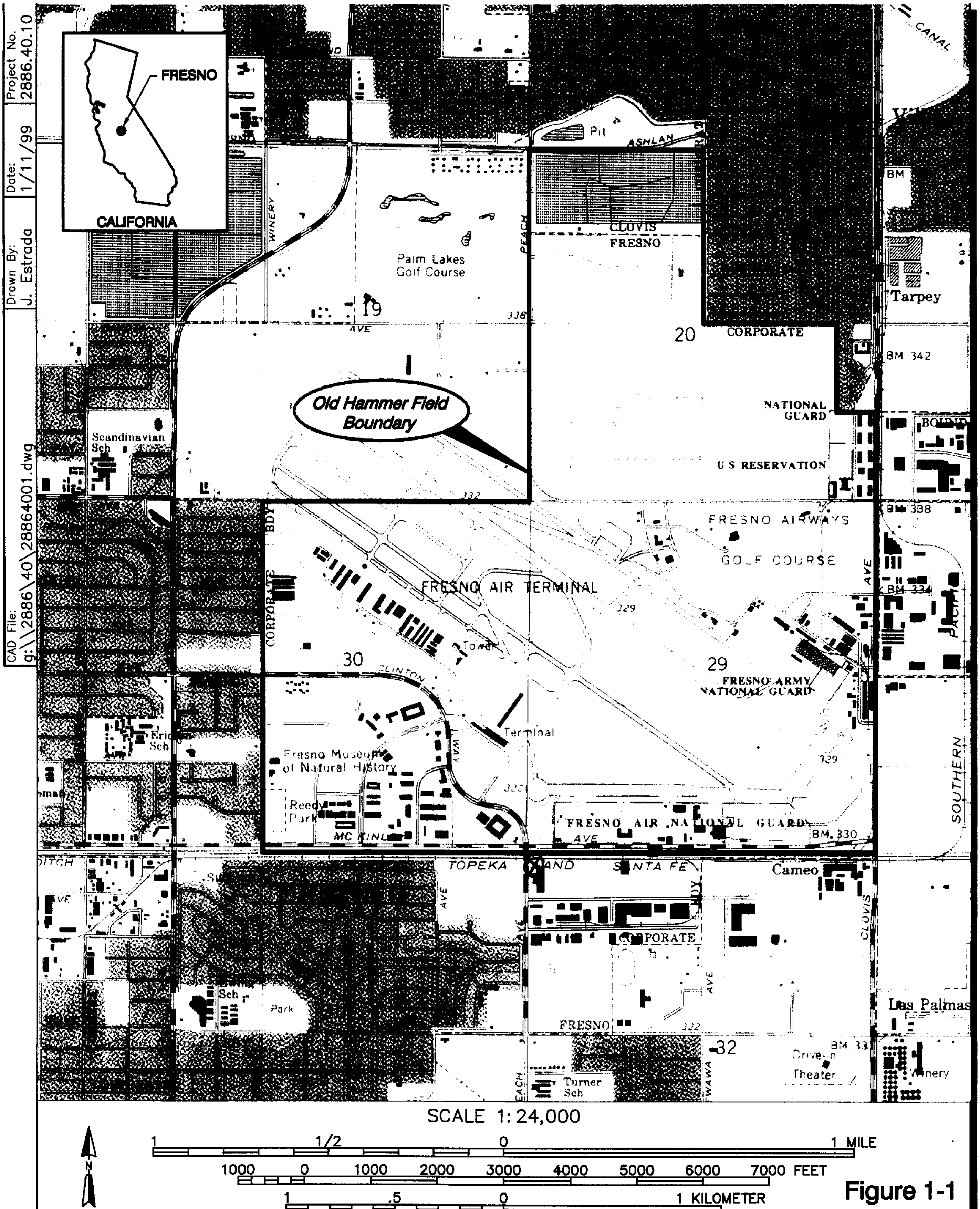

Figure 1-1
Site Location Map
Old Hammer Field
Fresno, California

ERM 1/99

References:
U.S.G.S. 7.5 Minute Series (Topographic Clovis Quadrangle)
Dated: 1964; Photorevised 1981

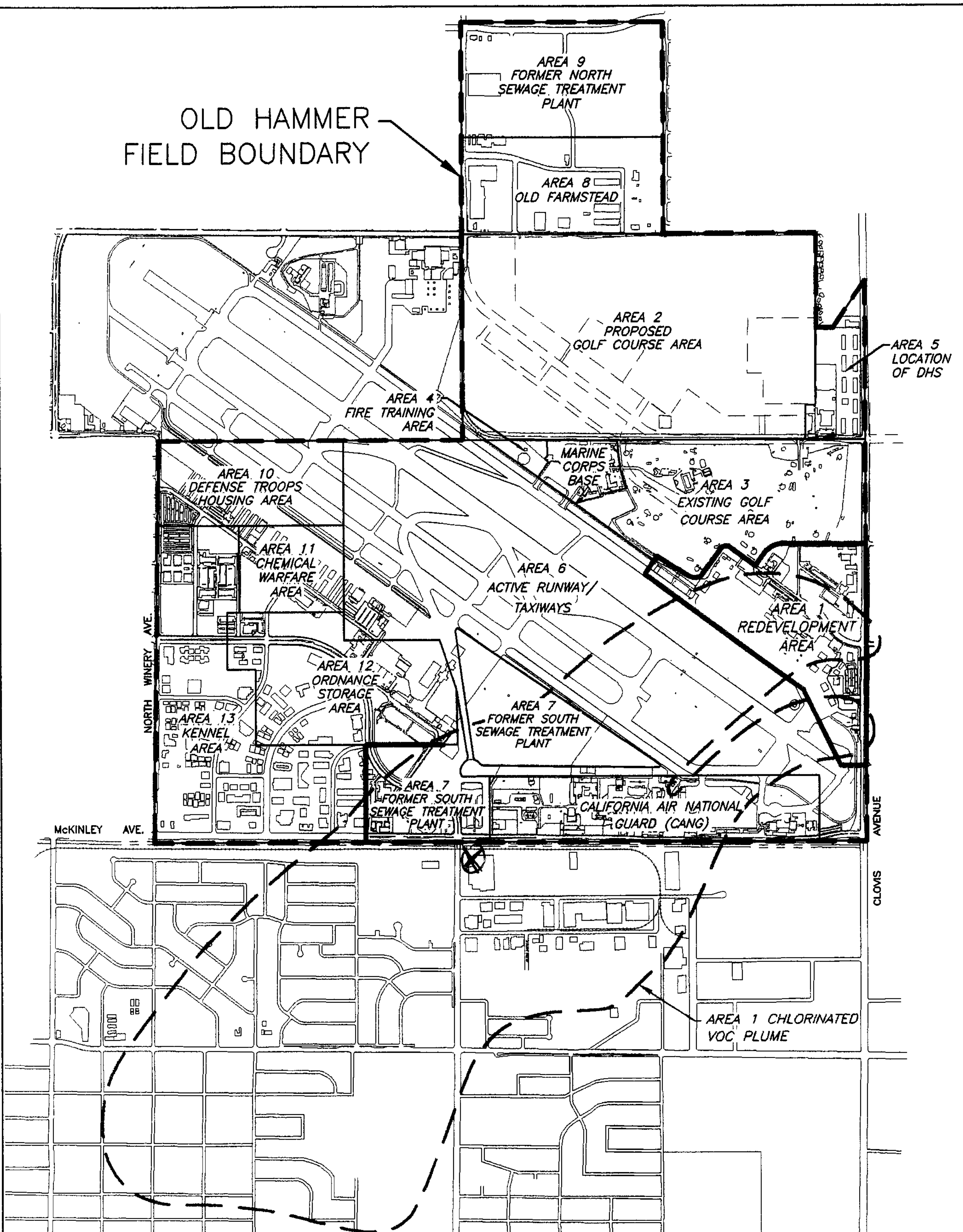

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Figure 1-2

Area 1 and Other OHF Investigation Areas

Old Hammer Field

Fresno, California

ERM 1/00

CAD File: g:\2885\50\28855004.dwg

Drawn By: J. Estrada

Date: 1/06/00

Project No. 2885.50